



Europäisches Patentamt  
European Patent Office  
Office européen des brevets



(11) EP 0 706 275 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:  
10.04.1996 Bulletin 1996/15

(51) Int. Cl.<sup>6</sup>: H04L 9/32, H04L 9/30

(21) Application number: 95113153.1

(22) Date of filing: 22.08.1995

(84) Designated Contracting States:  
DE FR GB

(30) Priority: 15.09.1994 US 306741

(71) Applicant: International Business Machines  
Corporation  
Armonk, N.Y. 10504 (US)

(72) Inventor: Arnold, Todd Weston  
Charlotte, NC 28262 (US)

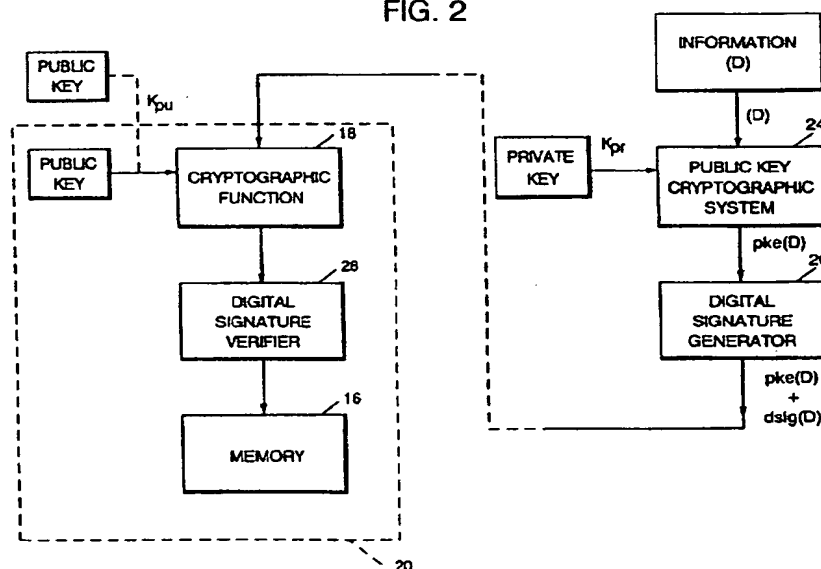
(74) Representative: Rach, Werner, Dr.  
IBM Deutschland  
Informationssysteme GmbH,  
Patentwesen und Urheberrecht  
D-70548 Stuttgart (DE)

(54) System and method for secure storage and distribution of data using digital signatures

(57) The present invention overcomes the disadvantages and limitations of the related art by providing an apparatus and method for secure distribution of software, software updates, and configuration data. Cryptography is used to protect software or data updates sent to computer products or peripherals using non-secure

distribution channels. In the preferred embodiment, the contents of the data cannot be read by anyone who obtains the data, and the data will not be accepted unless it is unmodified and originated with the valid source for such data.

FIG. 2



BEST AVAILABLE COPY

## Description

## BACKGROUND OF THE INVENTION

## 1. Field of the Invention

The present invention relates to an apparatus and method for secure distribution of data. More particularly, the present invention relates to an apparatus and method for secure distribution of software, software updates, and configuration data.

## 2. Description of Related Art

In today's business environment, data is one of the most valuable resources required for maintaining a competitive edge. As a result, businesses must often be able to maintain data confidentiality, readily determine the authenticity of data, and closely control access to data. As used herein, the term "data" means a representation of facts, concepts or instructions in a formalized manner suitable for communication, interpretation, or processing by human or automatic means, including, but not limited to, software, software updates, and configuration data.

Data systems commonly consist of many types and sizes of computer systems that are interconnected through many different electronic data networks. It is now common for an organization to interconnect its data systems with systems that belong to customers, vendors, and competitors. Larger organizations might include international operations, or they might provide continual services. For purposes herein, "computer" includes a device capable of performing the functions of a Turing Machine, including a microcomputer, minicomputer, or mainframe computer. A Turing Machine is a well-known computer science concept and is explained in Encyclopedia of Computer Science, Ed. Anthony Ralston, ISBN 0-88405-321-0, which is specifically incorporated herein by reference. "Memory" includes a device or devices for storing data for use by a computer, including electronic, magnetic, and electro-magnetic memory.

A combination of elements must work together to achieve a more secure environment. A security policy, based on an appraisal of the value of the data and potential threats to that data, provides the foundation for a secure environment.

Security functions can be categorized as follows:

- \* Identification and authentication. Identifies users to the system and provides proof that they are who they claim to be.
- \* Access control. Determines which users can access which resources.
- \* Data confidentiality. Protects an organization's sensitive data from unauthorized disclosure.
- \* Data integrity. Ensures that data is in its original form and that it has not been altered.
- \* Security management. Administers, controls, and reviews a business, security policy.
- \* Nonrepudiation. Assures that the message was sent by the appropriate individual.

Cryptography includes a set of techniques for scrambling or disguising data so that it is available only to someone who can restore the data to its original form. In current computer systems, cryptography provides a strong, economical basis for keeping data confidential and for verifying data integrity. Cryptography: A Guide for the Design and Implementation of Secure Systems, by Carl H. Meyer and Stephen M. Matyas, ISBN 0-471-04892-5, John Wiley & Sons, Inc. (1982), is a classic text on the design and implementation of cryptographic systems, which is specifically incorporated herein by reference.

For commercial business applications, the cryptographic process known as the Data Encryption Algorithm (DEA) has been widely adopted. The Data Encryption Standard (DES), as well as other documents, defines how to use the DEA to encipher data. Federal Information Processing Standards Publication 46, which defines DES, is reprinted in the Meyer & Matyas text. Many other processes for concealing data, such as protection of passwords and personal identification numbers (PINs), are based on the DES process. The DES algorithm uses a key to vary the way that the algorithm processes the data. A DES key is a very small piece of data (56 bits) that is normally retained in 8 bytes. The same key is used to transform the original data (plaintext) to its disguised, enciphered form (ciphertext) and to return it to its plaintext form. Because the DES algorithm is common knowledge, one must keep the key secret to make the data confidential; otherwise, someone who has the key that one used to encipher the data would be able to decipher the data. Key management refers to the procedures that are used to keep keys secret.

To confirm the integrity of data, one can use the DES algorithm to compute a message authentication code (MAC). Used in this way the DES algorithm is a powerful tool; it is almost impossible to meaningfully modify the data and still

have it produce the same MAC for a given key. The standardized approaches authenticate data such as financial transactions, passwords, and computer programs.

After the MAC has been computed, it is sent with data. To authenticate the data, the system uses the DES algorithm to recompute the MAC; the system then compares this result with the MAC that was sent with the data. Someone could, of course, change both the data and the MAC; therefore, the key that is used to compute the MAC must be kept secret between the MAC's originator and the MAC's authenticator.

An alternative approach to data integrity checking uses a standard key value and multiple iterations of the DES algorithm to generate a modification detection code (MDC). In this approach to data integrity checking, the MDC must be received from a trusted source. The person who wants to authenticate the data recomputes the MDC and compares the result with the MDC that was sent with the data.

Because the DES algorithm has been used for many years, its strength has been well demonstrated. Both software and specialized hardware can implement the DES algorithm. A hardware solution is often desirable for the following reasons:

- \* the algorithm requires many computer instructions to be processed
- \* the keys must be protected so that they can remain secret
- \* performance can be improved

If a data security threat comes from an external source, a software implementation of the cryptographic algorithm might be sufficient; unfortunately, however, much fraud originates with individuals within an organization (insiders). As a result, specialized cryptographic hardware can be required to protect against both insider and outsider data security threats. Well-designed hardware can do the following:

- \* ensure the security of cryptographic keys
- \* ensure the integrity of the cryptographic processes
- \* limit the key-management activities to a well-defined and carefully controllable set of services

The DES algorithm, which has been proven to be efficient and strong, is widely known; however the keys must normally remain secret. Because the same key is used both to encipher the data and to decipher the data, the process is said to be symmetric; it uses a symmetric key.

In another type of cryptographic process, an asymmetric process, one key is used to encipher the data, while a different but corresponding key is used to decipher the data to its original form. A system that uses this type of process is known as a public-key system. The key that is used to encipher the data is widely known, but the corresponding key for deciphering the data is secret. For example, many people who know a person's public key can send enciphered data to that person confidentially, knowing that only that person should possess the secret key for deciphering the data. Public-key cryptographic algorithms have been incorporated into processes for simplifying the distribution of secret keys and for assuring data integrity, including providing nonrepudiation by using digital signatures. Public-key and digital signature techniques are discussed in more detail the Meyer & Matyas text.

Public-key algorithms (e.g., RSA algorithm, by R. Rivest, A. Shamir, and L. Adleman) use a relatively large key and use even more computer time than the DES algorithm. The use of a public-key system is, therefore, often restricted to situations in which the characteristics of the public-key algorithms have special value.

In both the DES and RSA algorithms, no practical means exists to identically cipher data without knowing the cryptographic key; therefore, keeping a key secret at a cryptographic node is essential. In real systems, however, this often does not provide sufficient protection. If adversaries have access to the cryptographic process and to certain protected keys, they could possibly misuse the keys and eventually compromise the system. A carefully devised set of processes must be in place to protect and distribute cryptographic keys in a secure manner.

Access control protects data by allowing only persons or programs with a legitimate need to access system resources, such as a file, selected records or fields in a file, a hardware device, or the computing capability of the system. Access control uses the following services:

- \* Identification and verification. Identification is the ability to use a unique name, label, or other reference to identify each user or program to the system. Verification is the ability to provide proof that users and programs are who and what they claim to be. (Verification is also known as "authentication".)

\* Authorization. Authorization is the process whereby users or programs are restricted to specific resources, such as data sets, programs, or transactions. (Authorization is also known as "access control".)

\* Enforcement. Enforcement is a subsystem process of verifying the requester's authorization.

In systems that consist of multiple computers, it is increasingly necessary for persons or programs at one system to be able to convince persons or programs at another system that they are entitled to receive service. Common solutions to this problem involve the following:

- \* using local access controls
- \* using cryptographic processing to ensure the authenticity of a process
- \* ensuring that the authorization information is confidential

Many computer products and peripherals now have their own intelligence, separate from the computer itself, in the form of integrated microprocessors. These microprocessors use stored programs to provide some part of the device's function.

For example, the IBM 4755 Cryptographic Adapter is a device which includes a microprocessor, memory, and programming logic mounted on a printed circuit board. Functions are housed within a tamper-resistant module, or secured area, for protection, such as that discussed more fully in U.S. Pat. No. 5,027,397, which is specifically incorporated herein by reference. The IBM 4755 is a component of the IBM Transaction Security System, discussed in the IBM publication entitled "Transaction Security System: General Information Manual and Planning Guide" (GA34-2137-0), U.S. Pat. No. 5,048,085, and U.S. Pat. No. 5,148,481, which are specifically incorporated herein by reference.

Typically, two kinds of memory are associated with these microprocessors: permanent (unalterable or nonvolatile) memory for the program; and volatile memory for data used by the program. Permanent memory is typically Read Only Memory (ROM), Programmable Read Only Memory (PROM), or Erasable Programmable Read Only Memory (EPROM). Volatile memory is typically a static or dynamic Random Access Memory (RAM), which loses all stored data when power is removed.

Newer technologies allow the designer to use memory which is nonvolatile, but reprogrammable. That is, memory in which the data can be changed, but the contents are retained when the power is off. Several technologies can be used to obtain these characteristics. Flash EPROM (FEPRM) permits areas of memory to be erased electronically and then reprogrammed. Electrically Erasable PROM (EEPROM) permits individual bytes or bits to be rewritten much like RAM memory. Complementary Metal-Oxide Semiconductor (CMOS) RAM with battery back-up uses little power and retains RAM contents when system power is off.

These newer kinds of memory can be used in two ways to improve the value of the product.

First, if some or all of the microprocessor program is stored in nonvolatile, reprogrammable memory, the program can be changed after the product is manufactured. Thus, new features can be added and errors can be corrected. This prevents product obsolescence and protects the manufacturer from high warranty costs when errors occur.

Second, data stored in the memory can control the configuration of the product. One such use is to selectively enable or disable product features. In this way, the manufacturer can produce a standard product, and sell it for a variety of applications which need different features. Users can be charged for an upgrade to enable new features, which will be highly profitable to the manufacturer since no new hardware has to be shipped or installed.

There are many circumstances which would make it advantageous to be able to target such upgrades to a specific subset of the total population of devices. The reason may be to prevent applying an upgrade that is incompatible with the underlying hardware or software, or it may be to restrict the upgrade to a specific set of users or devices. For example, the manufacturer may want to apply the upgrade only to devices which have:

- \* a particular model number
- \* a manufacture date within a particular range of dates
- \* a particular version of software installed
- \* a certain ranges of serial numbers
- \* a specific combinations of features

It is easy to see why this kind of flexibility is highly desirable, for both the manufacturer and the user. There is a significant impediment to its use, however; security.

Both the manufacturer and user want to be sure they have control over programs that are loaded into the memory. The manufacturer may want to make sure only its programs are used, to ensure the programs meet quality and performance standards. The manufacturer may also want to prevent anyone from learning how the software works, or what the data is that is being sent to the user. The user, on the other hand, wants to make sure the programs in the devices are valid, and prevent any that might malfunction, or which might pose a security threat. An example of a security threat would be a "Trojan horse" program which would normally operate correctly, but which had "secret" features to circumvent the user's security practices, or to divulge the user's secret information.

Typically, there will be one source for all field upgrades to code or configuration data, although other scenarios are possible. For the purposes of discussion, assume that the device manufacturer is the only valid source of code or data updates; and the device is a security adapter card, with a secured area or module where data is protected from disclosure. The problem can then be described with two fundamental requirements:

First, data sent to the user must be kept secret. It must be impossible for anyone to discover or modify the contents of the data.

Second, the user must be able to verify that the data came from the valid source (e.g., the manufacturer). This is a form of non-repudiation.

## SUMMARY OF THE INVENTION

The present invention overcomes the disadvantages and limitations of the related art by providing an apparatus and method for secure distribution of software, software updates, and configuration data. Cryptography is used to protect software or data updates sent to computer products or peripherals using non-secure distribution channels. In the preferred embodiment, the contents of the data cannot be read by anyone who obtains the data, and the data will not be accepted unless it is unmodified and originated with the valid source for such data.

An advantage of the invention is to provide an apparatus and method for secure distribution of software, software updates, and configuration data.

Another advantage of the invention is to provide an apparatus and method wherein data stored in memory controls the configuration of a product so as to selectively enable or disable product features.

Yet another advantage of the invention is to provide an apparatus and method wherein data stored in memory controls the acceptance or rejection of proposed data for a product.

The foregoing and other advantages of the present invention will be apparent to those skilled in the art of information handling technology in view of the accompanying drawings, description of the invention, and appended claims.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram depicting a computer system and associated cryptographic system, wherein an enlargement of an embodiment of the cryptographic system is broken out.

FIG. 2 is a block diagram of an embodiment of the invented apparatus for secure distribution of software, software updates, and configuration data employing public key cryptography.

FIG. 3 is a flowchart of an embodiment of the invented method for secure distribution of software, software updates, and configuration data employing public key cryptography.

FIG. 4 is a block diagram of an embodiment of the invented apparatus for secure distribution of software, software updates, and configuration data employing public key cryptography and symmetric key cryptography.

FIG. 5 is a flowchart of an embodiment of the invented method for secure distribution of software, software updates, and configuration data employing public key cryptography and symmetric key cryptography.

FIG. 6 is a depiction of criteria information in tabular form.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, a computer or computer system 10 is shown which includes a cryptographic system 12 comprising a microprocessor 14, memory 16, and cryptographic functions 18 mounted upon a device or adapter card 20. The microprocessor, memory, and cryptographic functions are housed within a secured area or module 22.

As shown in FIG. 2, a public key KPU is installed in the adapter card 20. Cryptographic system 12 includes the public key algorithm (e.g., RSA). The corresponding private key KPR would be held by, for example, the adapter card manufacturer, in a secure, secret manner so it would never be disclosed outside the manufacturer's organization. Preferably, the data is protected twofold:

First, as shown in FIG. 2, data, D, is encrypted by a public key cryptographic system 24 using the private key, KPR, or as shown in FIG. 4, data is encrypted by a symmetric key cryptographic system 25 using the symmetric key, KS. This provides the necessary secrecy; the data content cannot be determined by anyone intercepting the data, and any modification to the encrypted data will render it invalid.

Second, in FIGS. 2 and 4, a digital signature on the data is computed and sent to the adapter card users using a digital signature generator 26. This signature is verified before the data is accepted by digital signature verifier 28, which can be a component of cryptographic function 18 or a separate function as shown. Preferably, cryptographic function 18 include both a public key cryptographic system 18a and a symmetric cryptographic system 18b. A verified digital signature proves that the data has not been altered since its creation, and proves that the originator was, in this example, the manufacturer.

Two embodiments of the invention are described below.

#### Using only public key cryptography

The first four steps in FIG 3. are performed by the manufacturer, who sends the resulting data to the users. The remaining steps are performed by the user to load the data into the adapter card.

The manufacturer first generates the data to be loaded into the adapter cards in step 100. This data is designated D. The manufacturer already possesses private key KPR, and the corresponding public key KPU is with every adapter card manufactured. The key KPU may be embedded in the adapter card, or may be supplied externally on a diskette or other medium if it is protected against substitution (e.g., by a certification process). It does not need to be kept secret in order to maintain integrity of the loaded data.

In step 110, the manufacturer computes a digital signature on the data D using the private key KPR. The use of the digital signature is optional. Its use enhances the ability to prove the source of the data, but the data can be distributed successfully without a signature. The digital signature function is represented as dsig(). The signature will be verified before the data is accepted by the adapter card, assuring it came from the manufacturer in this example.

In step 120, the data D is encrypted using the private key algorithm with key KPR. This protects the data from disclosure or modification prior to its installation in the adapter card. The function pke() represents a public key encryption algorithm, such as the RSA algorithm.

The manufacturer, in step 130, sends the encrypted data pke(D) and the digital signature dsig(D) to the card users through any convenient channel; diskettes, electronic mail, or any other medium is sufficient. The user receives this information, and loads the data and signature into the secured area of the adapter card in step 140.

In step 150, the adapter decrypts the data using the public key KPU, recovering the clear data D. Following this, in step 160, the digital signature is verified using the same key. If the signature verifies, the data is genuine and it can only have been created by the manufacturer, who holds the private key KPR. Once the data has been decrypted and its validity has been determined, the data is applied to the nonvolatile memory in the adapter card, step 180; otherwise, the information is discarded, step 170.

Only the private key KPR needs to be kept secret. The public key KPU is present in every copy of the device, and there is no security exposure if its value is divulged. The nature of the public key algorithms guarantees that the private key cannot be determined from the public key, and that valid data cannot be generated with knowledge of the public key alone.

#### Using public key and symmetric key cryptography

Alternatively, the data can be encrypted using a symmetric key cryptographic algorithm (e.g., DES) instead of the public key algorithm used above. With current technology, symmetric key algorithms are generally faster to compute than public key algorithms, so this method is presently preferable. A randomly selected symmetric algorithm key is used each time new data is produced.

As shown in step 200 of FIG. 5, the manufacturer generates the data D to be sent to the installed cards in the field. In the step 210, a random symmetric algorithm key designated KS is generated. The users do not have key KS, so the manufacturer must send it to them in a secure manner. In step 220, KS is encrypted with a public key algorithm using the private key KPR.

In step 230, the manufacturer computes a digital signature over the data D, and in step 240 the data is encrypted using the symmetric key algorithm with key KS. The encrypted KS, the encrypted data pke(D) and the digital signature dsig(D) are all sent to the user in step 250.

In step 260, the data is received at the user site where adapter cards are installed. The data is loaded into the secured area of the card, which contains the public key KPU. In step 270, KPU is used to decrypt the symmetric key KS using the public key algorithm. In step 280, the recovered KS is used to decrypt the data using the symmetric key algorithm.

In step 290, the digital signature is verified using KPU, in order to verify the origin of the data. If the signature verifies, it means that both the data D and the key KS were valid; in this case, the data is loaded into the nonvolatile memory on the adapter card and enabled for use, step 310. Otherwise, the data is discarded or otherwise rejected. All cryptographic calculations are preferably performed inside the secured area, so there is no threat of data manipulation while the data is recovered and verified.

With either method described above, other checking codes could be used as an alternative to the digital signature. An MDC, cyclic redundancy check (CRC), or any other valid checking code could be calculated over the data and appended to the data before it is encrypted. Once the data has been decrypted in the adapter card's secure environment, this value could be verified against the recovered data. If it verifies, the data is correct and originated with the holder of the private key KPR.

#### Use of information in the data as decision criteria

Once the data has been loaded into the adapter card, the decision of whether to permit the data to be employed can be made a function of information and/or instructions contained within the data itself.

In one embodiment, software contained in the device is used to compare "criteria information" in the data with "basic information" already contained in the device. Examples of such basic information include:

- \* serial number
- \* model codes
- \* date of manufacture
- \* version of software currently installed
- \* codes describing installed or available features

The basic information in the device is stored in memory (including hardware registers, permanent software, or resident loadable software). The criteria information is preferably included in the data in tabular form, for example, as shown in FIG. 6. The data, and therefore the criteria information, is securely distributed in the manner described in the previous sections herein. Control software within the device examines this table and compares it to the appropriate basic information in order to decide whether to apply the data.

The pseudocode in Table 1 is an example of how the criteria information from the table would be processed. Each item in the table would be compared with the appropriate basic information contained within the device itself. The results

of the comparisons would be used to determine whether the data should be applied to the particular device.

TABLE 1

```

Load_Permitted = FALSE;
If SN_Min <= SN <= SN_Max then Do;
  If DT_Min <= DT <= DT_Max then Do;
    If Min_HW_Lvl <= HW_Lvl <= Max_HW_Lvl then Do;
      If Min_SW_Lvl <= SW_Lvl <= Max_SW_Lvl then Do;
        Get Feature_Vector;
        If all Features_Required features are present then Do;
          If no Features_Prohibited features are present then
            Do;
              If Model_List is empty then Load_Permitted = TRUE;
            Else do While Model_List not empty;
              Get Test_Model from head of Model_List;
              If Test_Model = model of this device
                then Load_Permitted = TRUE;
            If Load_Permitted = TRUE then load data to memory;
          Else Abort loading process

```

\* SN\_Min and SN\_Max are the lowest and highest serial numbers the device can have for the data to be valid. In the pseudocode in Table 1, the serial number for a specific device is designated SN.



- 5           \*     DT\_Min and DT\_Max are the earliest and latest dates  
the device can have for the data to be valid, e.g.,  
the manufacturing date, the microcode creation date,  
or some other date code. Several different dates  
could be compared if desired. In the pseudocode in  
10           Table 1, the date code for a specific device is  
designated DT.
- 15           \*     Min\_HW\_Level and Max\_HW\_Level are the lowest and  
highest hardware levels the device can have for the  
data to be valid. This represents the version of  
hardware in the device. HW\_Level is used in the  
20           pseudocode to represent a particular device's  
hardware level.
- 25           \*     Min\_SW\_Level and Max\_SW\_Level are the lowest and  
highest software levels the device can have for the  
data to be valid. This represents the version of  
software in the device prior to application of the  
30           data. SW\_Level is used in the pseudocode to  
represent the particular device's software level.
- 35           \*     Features\_Required and Features\_Prohibited are  
vectors of boolean values. They represent the  
features the device must have for the data to be  
valid, and the features the device must not have for  
40           the data to be valid. In the pseudocode,  
Feature\_Vector represents a vector of boolean values  
representing the features present in a specific  
device.
- 45           \*     Model\_List is a list of product models which are  
valid targets for the data. An empty list can be  
used to indicate that the data is valid for all  
50           models. Otherwise, the device looks for its own  
model code in the list; if it is not present, the  
data will not be applied.

55           In an alternative embodiment, one implementation of which is illustratively shown in pseudocode in Table 2, the data itself contains special software ("checking software") to determine if the data should be applied to the device. The data, and therefore the checking software, is securely distributed in the manner described in the previous sections herein.

This checking software is not a part of the operational software used in the everyday application of the device. The additional checking software may be optional; if present, it is called by the control software which resides in the device, and it determines whether the data should be applied. The same checking software can also contain special initialization instructions to prepare the device for the new software or data contained in the data.

TABLE 2

```

-----
If checking software present in the data then Do;
  Load checking software;
  Verify checking software is valid;
  Abort if invalid;
  Execute checking software;
  If result = "ok to load data" then Do;
    Get data;
    If data is valid
      Then load data to memory;
  Else abort
-----

```

This embodiment is more flexible than the first embodiment since its functions are not limited to a set conceived by the initial device designers. Functions can be added with any data update, simply by changing the checking program.

In operation, this embodiment can be combined with the first embodiment. A fixed set of checking functions can be permanently stored in the device, with additional functions contained in the checking software portion of the data.

The function performed by the checking software is completely up to the designer of that software. Its functions would typically be similar to those described for the first embodiment, but could include any checking or initialization deemed necessary by the designer.

A similar approach can be used to provide optional software that would be executed immediately after the data is loaded. This could perform initialization necessary to prepare the updated device for use.

Of course, many modifications and adaptations to the present invention could be made to advantage without departing from the spirit of this invention. Further some features of the present invention could be used without corresponding use of other features. Accordingly, this description should be considered as merely illustrative of the principles of the present invention and not in limitation thereof.

Furthermore disclosed is:

1. A method of securely controlling the configuration of a computer system so that features of the system may be conveniently enabled or disabled, said method including the steps of:  
providing memory which is located within a secured area which is protected from physical and direct electrical access;  
executing a program which requires specific information to be stored in the memory to permit the use of specific features of the system; and  
updating the specific information with data decrypted from encrypted data originating from another computer system.
2. The controlling method of item 1 including the additional steps of:  
encrypting the data at the other computer system under a first key of a public key encryption system; and  
decrypting the data within the secured area with a second key of the public key encryption system.
3. The controlling method of claim 22 including the additional steps of:  
generating a symmetric key for use with a symmetric cryptography algorithm;  
encrypting the data under the generated symmetric key;

encrypting the generated symmetric key under a first key of a public key encryption system;  
transferring the encrypted data and the encrypted symmetric key to a processing system which is located within the secured area;  
decrypting the received symmetric key within the secured area with a second key of the public key encryption system;  
5 decrypting the received data within the secured area under the decrypted symmetric key with a symmetric cryptography algorithm; and  
storing the decrypted data in said memory.

4. The loading method of item 3 wherein  
10 the first key is a private key used with said public key encryption system.

5. The loading method of item 3 or 4 wherein  
the second key is a public key used with said public key encryption system.

15 6. The controlling method of one of items 1 to 5 wherein  
the executed program is included in the data originating from the other computer system.

7. The controlling method of one of items 1 to 6 wherein said specific information corresponds to at least one of the  
20 following:  
serial number of the computer system;  
model number of the computer system;  
date of manufacture of the computer system;  
version of software currently installed in the computer system; and  
codes describing installed or available features.

25 8. The controlling method of one of items 1 to 7 wherein  
the features of the system are related to software updates included in the data originating from the other computer system.

30 9. A method of securely controlling the enablement of data loaded in memory within a secured area of a device,  
said method including the steps of:  
providing information within said memory representing at least one characteristic related to said device;  
providing criteria information within said data to be compared with said at least one characteristic;  
35 comparing said criteria information with said at least one characteristic; and  
enabling said data to be used within said device if said at least one characteristic meets said criteria information.

10. The controlling method of item 9, wherein  
at least some portion of said comparing step is performed in accordance with instructions contained within said data.

40 11. The controlling method of item 9 or 10, wherein  
said characteristic information corresponds to at least one of the following:  
serial number of the device;  
model number of the device;  
date of manufacture of the device;  
45 version of software currently installed in the device; and  
codes describing installed or available features.

## Claims

- 50 1. A method of transferring data into a secured area, said method including the steps of:  
encrypting (120) said data under a first key of a public key encryption system (24);  
transferring (130) said encrypted data to a processing system which is located within said secured area;  
decrypting (150) said received data within said secured area with said public key encryption system (24) under a  
second key; and  
55 storing said decrypted data within said secured area.
2. The method of claim 1, wherein  
said transferring data into a secured area is a loading data into at least some portion of memory which is located  
within said secured area, and

said secured area is protected from physical and direct electrical access, thereby guarding against undesired detection of said transferred data.

3. A method of loading data into at least some portion of memory which is located within a secured area which is protected from physical and direct electrical access, thereby guarding against undesired detection of said loaded data, said method including the steps of:  
generating (210) a symmetric key ( $K_S$ ) for use with a symmetric cryptography algorithm;  
encrypting (240) said data under said generated symmetric key ( $K_S$ );  
encrypting (220) said generated symmetric key ( $K_S$ ) under a first key of a public key ( $K_{PU}$ ) encryption system;  
transferring (250) said encrypted data and said encrypted symmetric key ( $K_S$ ) to a processing system which is located within said secured area;  
decrypting (270) said received symmetric key ( $K_S$ ) within said secured area with a second key of said public key ( $K_{PU}$ ) encryption system;  
decrypting (280) said received data within said secured area with said decrypted symmetric key ( $K_S$ ) with a symmetric cryptography algorithm; and  
storing said decrypted data into said at least some portion of memory.
4. The method of one of claims 1 to 3, wherein  
said first key is a private key ( $K_{PR}$ ) used with said public key ( $K_{PU}$ ) encryption system.
5. The method of one of claims 1 to 4, wherein  
said second key is a public key ( $K_{PU}$ ) used with said public key ( $K_{PU}$ ) encryption system.
6. The method of one of claims 1 to 5, wherein  
said public key ( $K_{PU}$ ) is stored within said secured area.
7. The method of one of claims 1 to 6 further including the step of:  
adding a code to said encrypted data which is to be transferred for the purpose of providing the capability of authenticating said encrypted data.
8. The method of claim 7 wherein  
said code is selected from said group consisting of a digital signature, a modification detection code (MDC), and a cyclic redundancy check (CRC).
9. The method of claim 7 or 8 further including the step of:  
authenticating said decrypted data; and  
enabling said decrypted data to be used if said decrypted data is authentic; otherwise, not enabling said decrypted data.
10. A system for securely holding data, said system comprising:  
memory means located within a secured area which is protected from physical and direct electrical access;  
means for providing a public key ( $K_{PU}$ ) within said secured area;  
means within said secured area for receiving data encrypted by a corresponding private key ( $K_{PR}$ ); and  
means within said secured area for decrypting (150) said received data under said public key ( $K_{PU}$ ).
11. The system of claim 10 wherein  
said decrypted data provides a symmetric key ( $K_S$ ).
12. The system of claim 11 including:  
means within said secured area for receiving data encrypted by a symmetric algorithm under said symmetric key ( $K_S$ );  
means for decrypting (280) said data under said symmetric key ( $K_S$ ) provided by said decryption under said public key ( $K_{PU}$ ); and  
means for storing said symmetric key decrypted data in said memory means.
13. The system of one of claims 10 to 12 further including  
means for analyzing a code received by said system to authenticate said data received.

14. The system of claim 13, wherein  
said code is selected from said group consisting of a digital signature, a modification detection code (MDC), and a  
cyclic redundancy check (CRC).

5 15. A method of securely controlling the configuration of a computer system (10) so that features of said system may  
be conveniently enabled or disabled, said method including the steps of:  
providing memory which is located within a secured area which is protected from physical and direct electrical  
access;  
10 executing a program which requires specific information to be stored in said memory to permit the use of specific  
features of said system; and  
updating said specific information with data decrypted from encrypted data originating from another computer sys-  
tem.

15 16. A method of securely controlling the enablement of data loaded in memory within a secured area of a device, said  
method including the steps of:  
providing information within said memory representing at least one characteristic related to said device;  
providing criteria information within said data to be compared with said at least one characteristic;  
20 comparing said criteria information with said at least one characteristic; and  
enabling said data to be used within said device if said at least one characteristic meets said criteria information.

FIG. 1

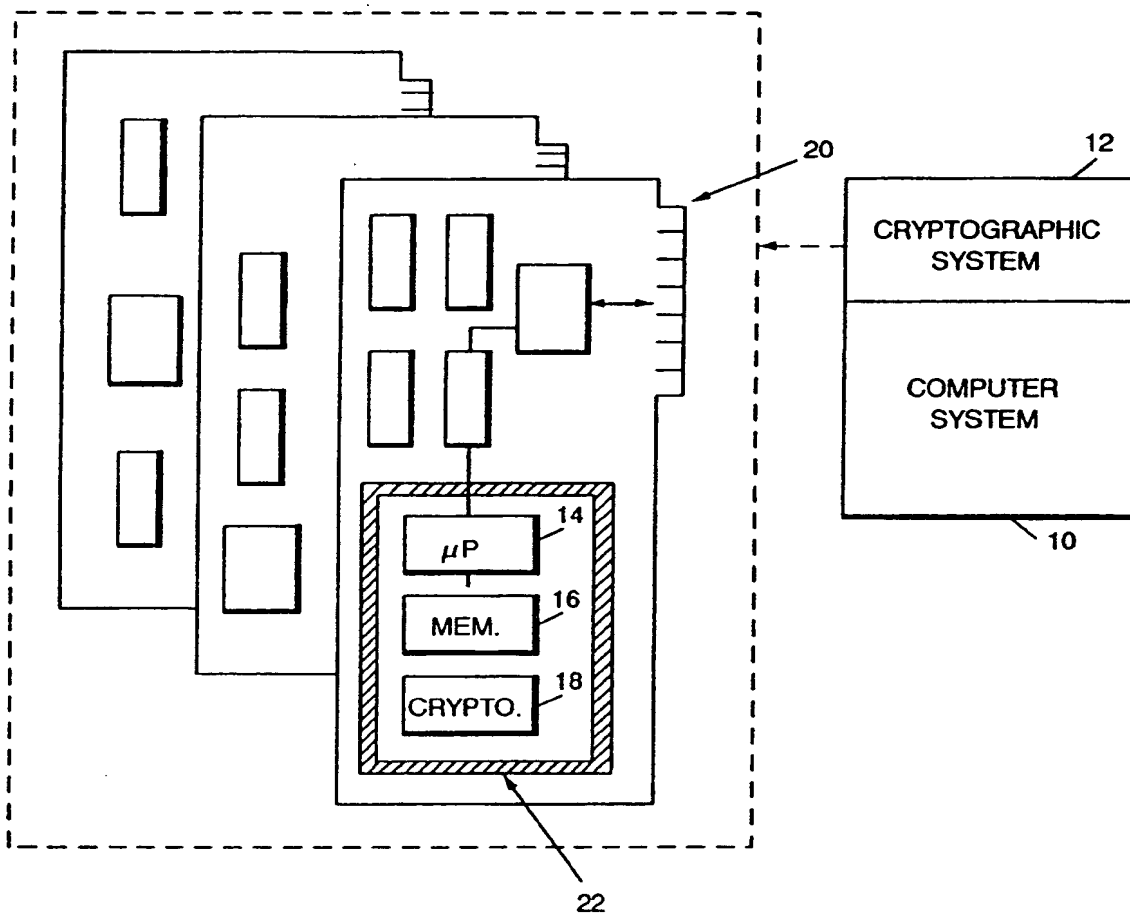


FIG. 2

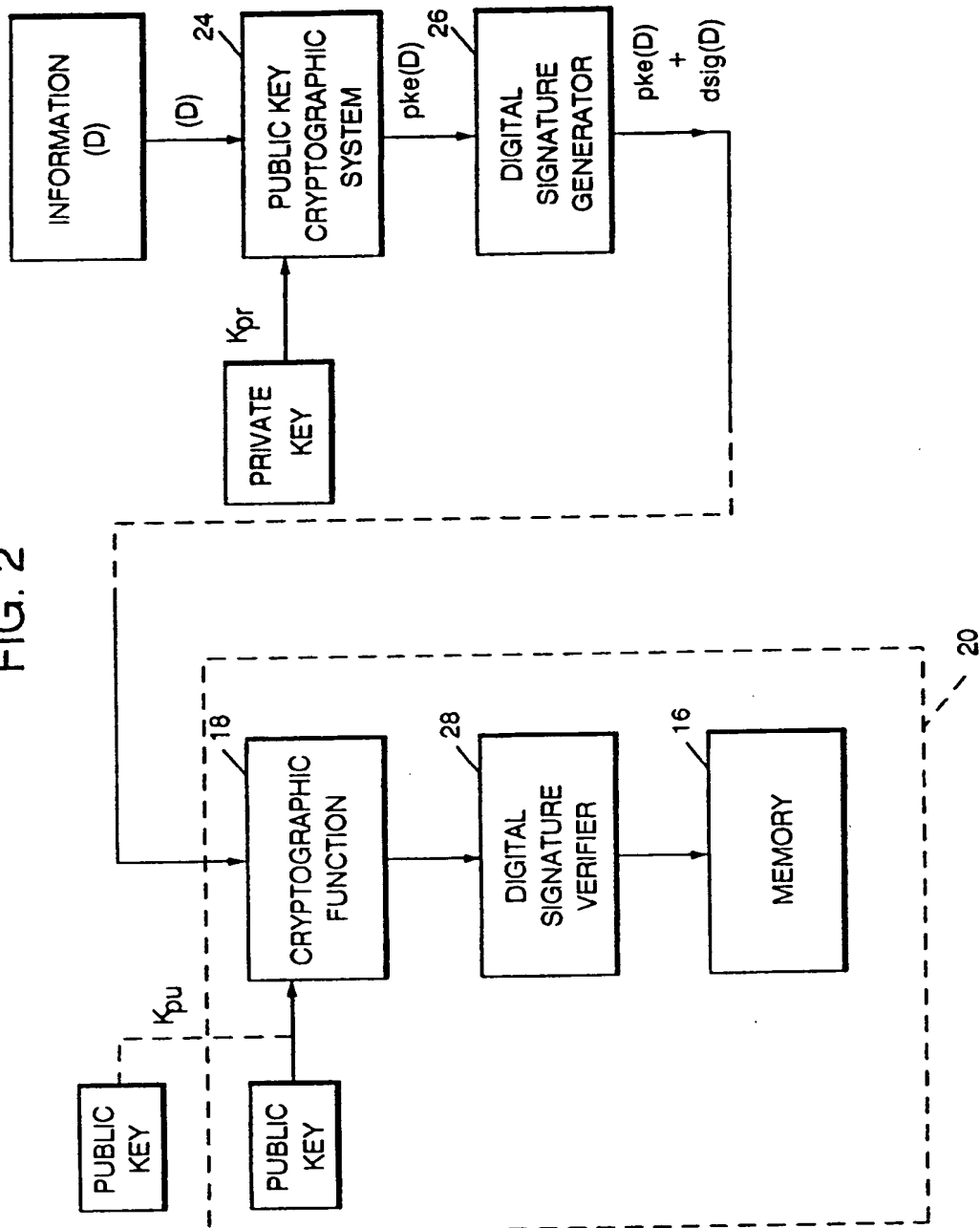
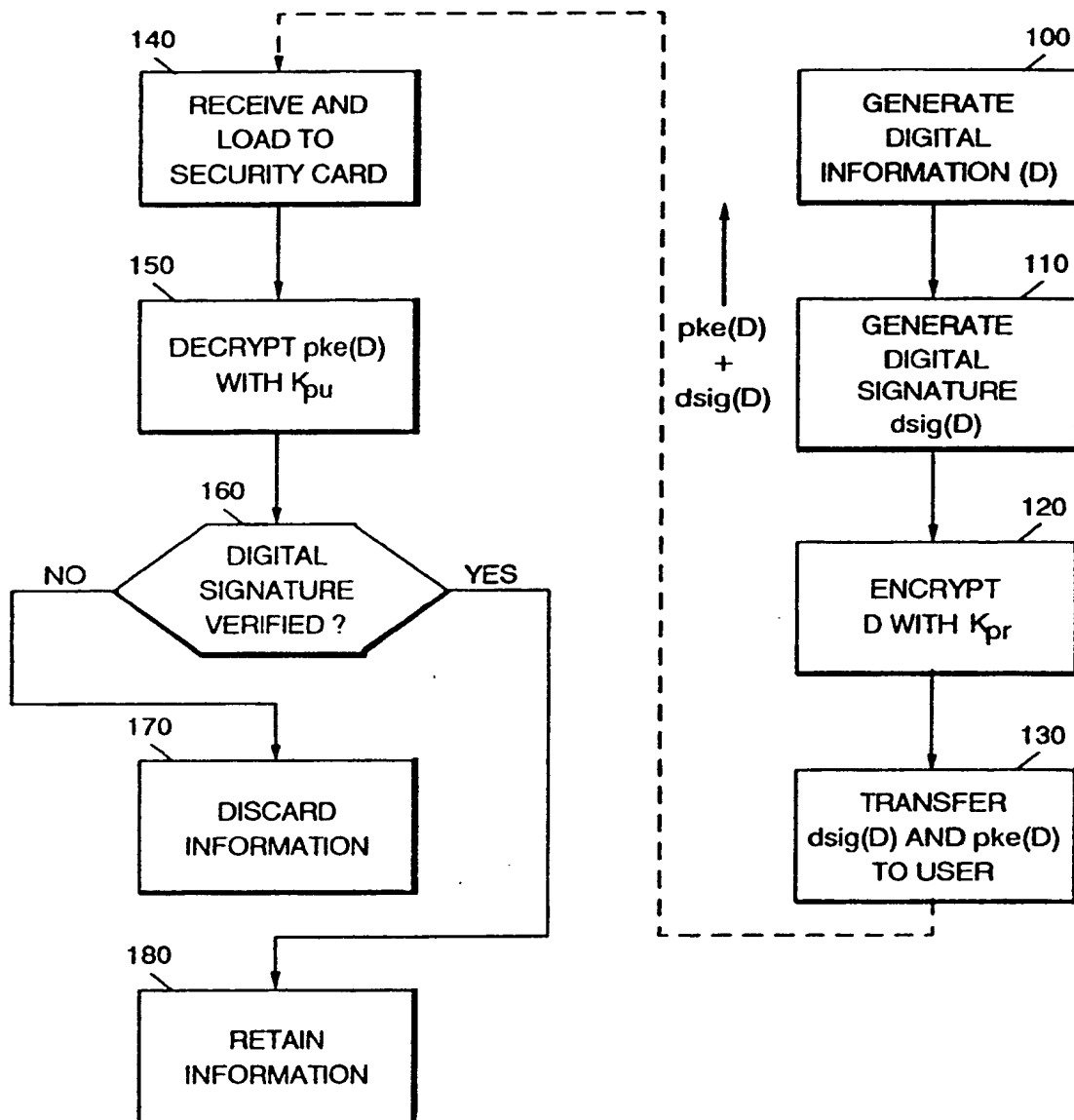


FIG. 3





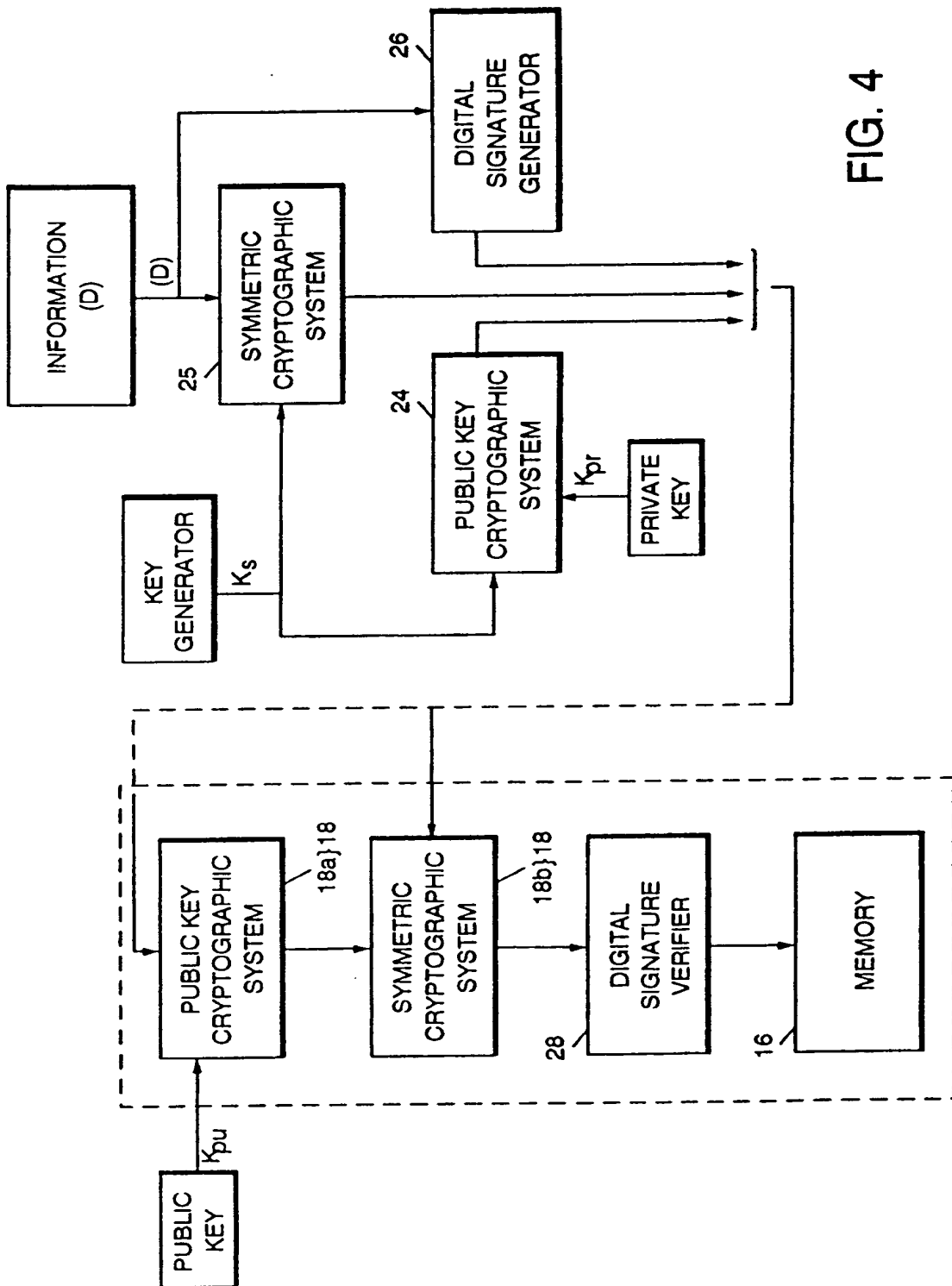


FIG. 4

FIG. 5

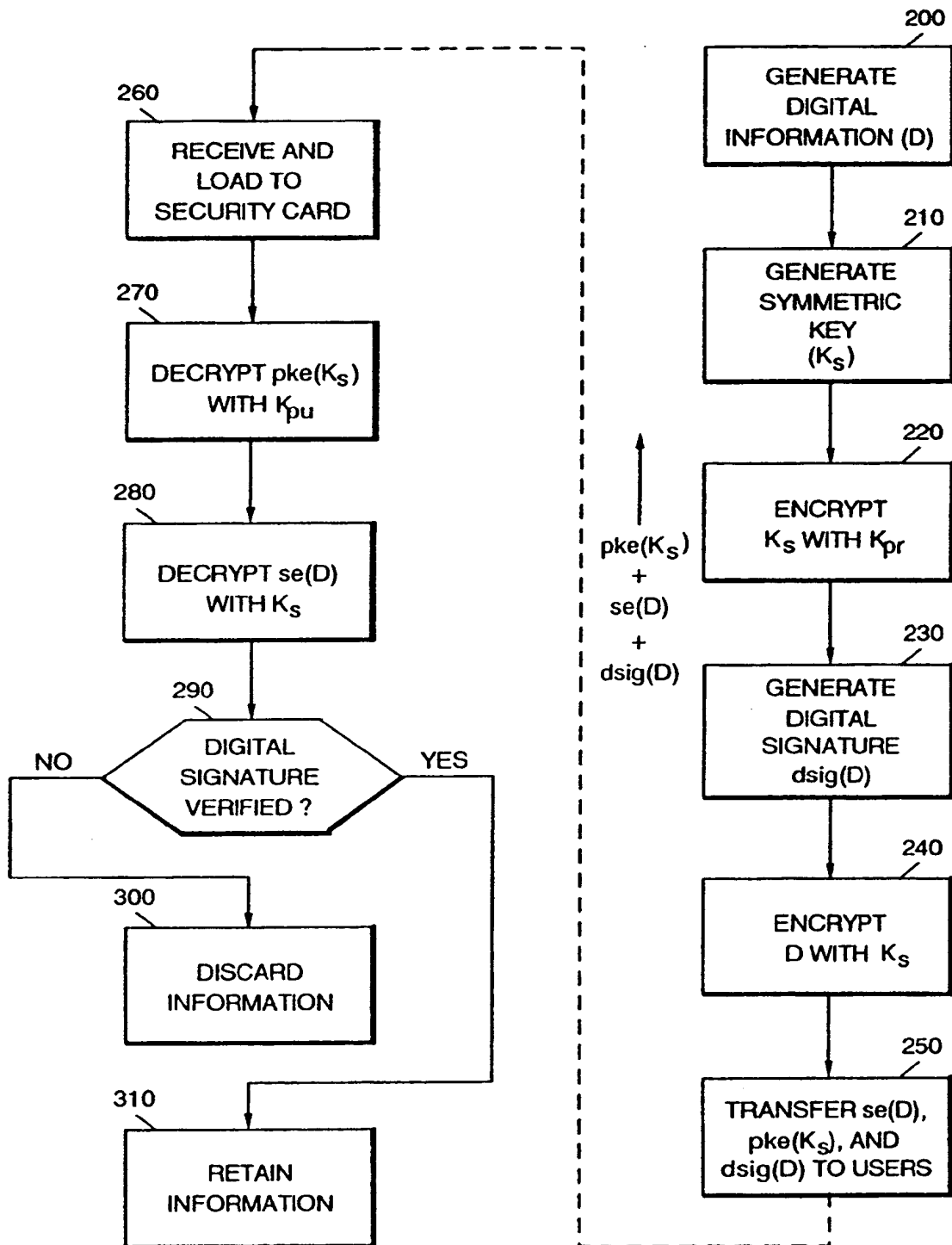
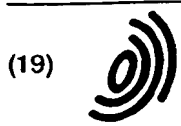


FIG. 6

SN_Min	SN_Max	→ RANGE OF SERIAL NUMBERS
DT_Min	DT_Max	→ RANGE OF DATES
Min_HW_Lvl	Max_HW_Lvl	→ RANGE OF HARDWARE LEVELS
Min_SW_Lvl	Max_SW_Lvl	→ RANGE OF SOFTWARE LEVELS
Features_Required		→ FEATURES THAT MUST BE PRESENT
Features_Prohibited		→ FEATURES THAT CANNOT BE PRESENT
Model_List		→ LIST OF VALID MODELS FOR UPDATE





Europäisches Patentamt  
European Patent Office  
Office européen des brevets



(11) EP 0 706 275 A3

(12) EUROPEAN PATENT APPLICATION

(88) Date of publication A3:  
30.06.1999 Bulletin 1999/26

(51) Int. Cl.<sup>6</sup>: H04L 9/32, H04L 9/30

(43) Date of publication A2:  
10.04.1996 Bulletin 1996/15

(21) Application number: 95113153.1

(22) Date of filing: 22.08.1995

(84) Designated Contracting States:  
DE FR GB

(30) Priority: 15.09.1994 US 306741

(71) Applicant:  
International Business Machines  
Corporation  
Armonk, N.Y. 10504 (US)

(72) Inventor: Arnold, Todd Weston  
Charlotte, NC 28262 (US)

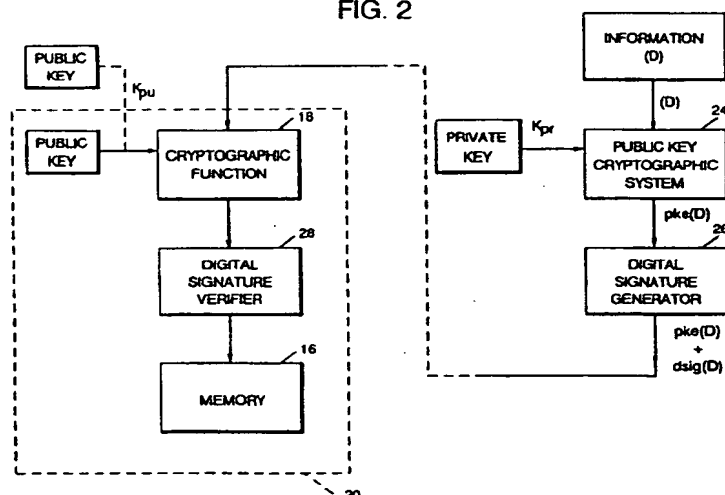
(74) Representative:  
Rach, Werner, Dr.  
IBM Deutschland  
Informationssysteme GmbH,  
Patentwesen und Urheberrecht  
70548 Stuttgart (DE)

(54) System and method for secure storage and distribution of data using digital signatures

(57) The present invention overcomes the disadvantages and limitations of the related art by providing an apparatus and method for secure distribution of software, software updates, and configuration data. Cryptography is used to protect software or data updates sent to computer products or peripherals using non-

secure distribution channels. In the preferred embodiment, the contents of the data cannot be read by anyone who obtains the data, and the data will not be accepted unless it is unmodified and originated with the valid source for such data.

FIG. 2





European Patent  
Office

## EUROPEAN SEARCH REPORT

Application Number  
EP 95 11 3153

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	BELLER M J ET AL: "FULLY-FLEDGED TWO-WAY PUBLIC KEY AUTHENTICATION AND KEY AGREEMENT FOR LOW-COST TERMINALS" ELECTRONICS LETTERS, vol. 29, no. 11, 27 May 1993, pages 999-1001, XP000372923 * page 1001, column 1, paragraph 3; figure 1 *	1-14	H04L9/32 H04L9/30
X	BELLER M J ET AL: "PRIVACY AND AUTHENTICATION ON A PORTABLE COMMUNICATIONS SYSTEM" IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, vol. 11, no. 6, 1 August 1993, pages 821-829, XP000403646 * page 827, column 2 - page 828, column 1; figure 5 *	1-14	
X	EP 0 535 863 A (AMERICAN TELEPHONE & TELEGRAPH) 7 April 1993 * page 11, line 18 - line 57; figure 6 *	1-14	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
X	DAVIDA G I ET AL: "DEFENDING SYSTEMS AGAINST VIRUSES THROUGH CRYPTOGRAPHIC AUTHENTICATION" PROCEEDINGS OF THE SYMPOSIUM ON SECURITY AND PRIVACY, OAKLAND, MAY 1 - 3, 1989, 1 May 1989, pages 312-318, XP000041247 INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS * page 313, column 2 - page 316, column 2 *	15,16	H04L
D,A	US 5 148 481 A (ABRAHAM DENNIS G ET AL) 15 September 1992 * figure 4 *	1-16	
-/--			
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 4 May 1999	Examiner Zucka, G
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons &amp; : member of the same patent family, corresponding document</p>			

EPO FORM 1503 03/82 (P04C01)



European Patent  
Office

# EUROPEAN SEARCH REPORT

Application Number  
EP 95 11 3153

## DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
D,A	US 5 048 085 A (ABRAHAM DENNIS G ET AL) 10 September 1991 * figure 7 *	1-16	
D,A	US 5 027 397 A (DOUBLE GLEN P ET AL) 25 June 1991 * abstract *	15,16	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 4 May 1999	Examiner Zucka, G
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons &amp; : member of the same patent family, corresponding document</p>			

EPO FORM 1503 03 02 (P4/C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 95 11 3153

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

04-05-1999

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0535863 A	07-04-1993	US 5241599 A	31-08-1993
		AU 648433 B	21-04-1994
		AU 2351392 A	08-04-1993
		CA 2076252 A,C	03-04-1993
		JP 2599871 B	16-04-1997
		JP 6169306 A	14-06-1994
US 5148481 A	15-09-1992	US 5048085 A	10-09-1991
		CA 2026739 A,C	07-04-1991
		EP 0421409 A	10-04-1991
		JP 3237551 A	23-10-1991
US 5048085 A	10-09-1991	CA 2026739 A,C	07-04-1991
		EP 0421409 A	10-04-1991
		JP 3237551 A	23-10-1991
		US 5148481 A	15-09-1992
US 5027397 A	25-06-1991	DE 69031645 D	04-12-1997
		EP 0417447 A	20-03-1991
		JP 2049342 C	25-04-1996
		JP 3105538 A	02-05-1991
		JP 7082459 B	06-09-1995
		US 5159629 A	27-10-1992



**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record**

**BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☒ BLACK BORDERS
- ☒ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☒ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☒ GRAY SCALE DOCUMENTS
- ☒ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**

**THIS PAGE BLANK (USPTO)**